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ABSTRACT

An experiment was designed to test an instrument that could assist writers and editors in selecting strategies for improving the comprehensibility of written instructions. In addition, the study examined how successful professional writers are in improving passages selected for difficulty. The subjects, 150 experienced writers, were given an original passage to read and rate using the instrument. They then completed a multiple choice test for the passage. They were to revise the passage and rate their version. More than 500 students were then given either the original or the revised version of the passage and were tested on their comprehension of it. The findings tended to support traditional notions of the factors that contribute to effective written instruction, such as the importance of content and of student aptitude. The most suprising result of the study was the failure of the writers as a group to improve the comprehensibility or memorability of the two passages, even though the passages had been chosen because they seemed difficult to understand. This was true even though the writers were generally professional developers of instructional materials, even when they had in hand a set of guidelines for judging the comprehensibility of the passages, and even when they knew they were participating in an experiment related to the comprehensibility of passages. (Materials used in the study are appended.) (EL)

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FORMATIVE EVALUATION OF THE COMPREHENSIBILITY OF WRITTEN INSTRUCTION

James I. McLean

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FORMATIVE EVALUATION OF THE COMPREHENSIBILITY OF WRITTEN INSTRUCTION

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Introduction

Writers of instructional materials continually seek strategies and guidelines which might help to improve and assure the comprehensibility and learning effectiveness of materials as they are developed. Many instructional developers have emphasized the importance of using a readability formula to judge the suitability of text for a particular group of readers. However, a number of recent studies have demonstrated that when materials are revised to shorten sentence length and substitute familiar words for unfamiliar words, that the gains in comprehension are either insignificant or unimportant (Duffy and Kabance, 1982; Walmsley, Scott, and Lehrer, 1982; Johnson and Otto, 1982).

The professional literature in instructional development emphasizes actual trials of materials with subjects who represent the intended audience (Dick and Carey, 1978). Also, one group of researchers (Swaney, Janik, Bond, and Hayes, 1981) has successfully improved the comprehensibility of an insurance policy by taking reading protocols with a few subjects and then providing the results of the protocols to experienced document designers. These latter researchers stress that reliance solely on guidelines such as readability formulas and traditional editing strategies is risky. Although trials and reading protocols are expensive, they can help avoid the substantial costs to readers when materials are difficult to understand. Since editors are typically familiar with the subject matter, they can not easily predict all of the comprehension problems of the novice reader.

However, improved guidelines and strategies are still needed by writers and editors. Before administering materials on a trial basis, it is efficient to first make those improvements which can be made on the basis of experience and research. Otherwise, the attention of trial subjects will be taken up by problems which are obvious to the editor. Second, even when an editor receives data on problems encountered by trial subjects, the responsibility remains with the editor or writer to apply appropriate strategies to solve the problem. For example, if readers incorrectly apply a general rule to a specific case within their knowledge, the editor or writer must decide whether it is both necessary to state the rule more clearly and to provide additional clarifying examples. Third, there are many instances in which time and personnel are unavailable or so expensive that trials become impractical. Thus, trials are useful for identifying problems and testing the effectiveness of instruction, but trials do not make editorial guidelines and strategies obsolete.

The views expressed here are my own and do not purport to reflect the position of the Department of the Army or the Department of Defense. This research was performed for my doctoral dissertation with the University of Texas at Austin. The dissertation committee is chaired by Carol E. Kasworm and Diane L. Schallert.

Given this need for guidelines, I set out to design an instrument which could be used to assist writers and editors in selecting strategies for improving the comprehensibility of written instruction. At the same time, I wanted to see how successful professional writers are in improving passages selected for difficulty. I also hoped to better understand the relationships among the different guidelines and strategies used by writers and editors. With the exception of readability research, research concerning instructional materials has tended to focus upon only a few factors per study. In addition, the readability research has emphasized technical linguistic factors at the word and sentence level rather than guidelines emphasized in education such as the statement of objectives and the use of devices such as advance organizers and signaling techniques. The concept of readability has been broadened recently to address additional concerns:

> What are these larger considerations that a writer (or adaptor) must be concerned with? The writer should worry first of all about the overall presentation of ideas, i.e., the order in which ideas are to be presented and their logical interrelationships. He or she must also be concerned with more local organization, i.e., what the topic of discourse is at various points in the text, and where transitions between ideas need to be made. Since the intended reader may not possess requisite background knowledge to understand a fact or concept, the writer must sometimes fill in this information for the reader .... (Kantor & Davison, 1981, p.6)

In this context, I designed an instrument (McLean, 1984) with the hope of measuring both traditional and modern factors related to readability as well as the use of instructional devices such as the statement of objectives and the provision of practice exercises. Subsequently, I performed a study which sought to answer these four questions:

1. Given the instrument, are writers able to improve the comprehensibility of a passage before it is used in instruction?

2. Which items of the instrument will have predictive validity for writers?

3. Which items of the instrument will have predictive validity for reviewers?

4. What will be the appropriate scoring weights?

Method

Subjects

This study involved three categories of subjects:

Writers. I wrote letters to 799 members of the Association for Educational Communications and Technology and the National Society for Performance and Instruction and contacted 55 other colleagues in instructional development to ask them to serve as writer-subjects. Those volunteering (150) were randomly assigned one of two passages to revise. This produced 42 usable revisions of the first passage and 31 usable revisions of the second passage.

Judges. Five experienced education specialists in the Course Development Division, Academy of Health Sciences, participated in the development of the passage rating instrument. Five more participated in a corollary study to examine the validity of the vocabulary scale. Five of these first 10 served as judges, using the instrument to rate both the original and the revised passages. Six education specialists served as content judges, each rating half of the passages according to whether each passage provided sufficient information to answer each item on the corresponding test.

Students. Three incoming classes of military trainees at the Academy of Health Sciences participated. Passages were randomly assigned with the goal of administering the two original passages to 60 students each and the revised passages to 12 students each. Memory and comprehension tests from 962 of these subjects were usable for analysis. However, aptitude data were successfully retrieved for only 521 of thse subjects.

Materials.

Original passages. See Appendix A for copies of the two original passages.

Passage rating instrument. Descriptive anchors were developed for twelve different scales for rating passages. The content of these scales is summarized in Table 1. With the exception of the vocabulary scale, five judges marked each scale to designate where the anchors should be attached. The mean of these values was then used to select the site of attachment. For the vocabulary scale, however, a published word frequency list was used to select the words in each descriptive anchor and their point of attachment (Carroll, Davies, & Richman, 1971). The judges did screen words at the end of the vocabulary scale which included infrequent words to remove anomalies. An example of one of the scales, related to the statement of objectives is provided in Appendix B.

Tests. One 24-item multiple choice test was developed for each of the two original passages. Each test consisted of four levels of 6 items each. The levels were labeled as follows: "WORD MEANINGS," which tested knowledge of the meanings of words used but not generally defined in the original passages but which may have been defined in some revisions; "SENTENCE

Table 1

Items and Related Abbreviations

Item	Writer's rating of revision minus writer's rating of original	Writer's rating of revision	Mean rating of panel of five judges
1. Familiarity of vocabulary	VOCD$^{-,++}$	VOCF^{++}	VOCJ^{++}
2. Simplicity and shortness of sentences	SEND^{++}	SENF^{+}	SENJ$^{-,++}$
3. Use of examples, metaphors, and analogies	METD	METF	METJ^{++}
4. Use of illustrations	ILLD^{++}	ILLF^{+}	ILLJ^{++}
5. Use of devices to tap reader's knowledge	KNLD	KNLF^{-}	KNLJ^{++}
6. Appropriate level of elaboration and explanation	ELBD	ELBF^{+}	ELBJ$^{--,++}$
7. Variety, diversity, and informality	VARD^{+}	VARF	VARJ^{-}
8. Statement of objectives or purpose	OBJD^{++}	OBJF^{++}	OBJJ^{++}
9. Provision of student practice	PRCD	PRCF	PRCJ^{++}
10. Clarity of organization and relationships of parts of text	ORGD^{++}	ORGF^{++}	ORGJ^{-}
11. Clarity of anaphoric references	REFD	REFF^{+}	REFJ^{+}
12. Reading one's writing		RERF	

Note: All items are corrected in computations so that 100 is the hypothetically effective end of each scale. Underlined abbreviations represent factors that appear in at least one of the regression formulas for the aggregated cases in table 2.

\+ Significantly and positively correlated with at least one dependent measure, $p < .01$.

++ Significantly and positively correlated with at least one dependent measure, $p < .001$.

\- Significantly and negatively correlated with at least one dependent measure, $p < .01$.

-- Significantly and negatively correlated with at least one dependent measure, $p < .001$.

MEANINGS," which tested knowledge of relationships within single sentences in the original passages; "LOCAL MEANINGS," which tested relationsips of 6 pairs of contiguous sentences located in each of the original passages; and "GLOBAL MEANINGS," which tested judgment of the author's purpose, the best title, the best summary, the worst metaphor, and the best structural depiction of the macrostructure of the text. Since a copy of the appropriate test was provided to each of the revising writers, there was an opportunity for each writer to "teach the test."

Rewriting of Passages and Writers' Ratings of Original and Revised Passages

A copy of an original passage and its appropriate test were randomly assigned to each writer. In a letter of instructions, each writer was first asked to read and rate the original passage. The following guidelines were suggested for use as they revised the passage:

a. Please do not simply try to use strategies implied by the "thermometers." Use whatever strategies you think will work.

b. Please avoid attempts to "teach" verbatim the items of the comprehension test. However, you should try to teach well the concepts and meanings measured by the items.

c. Please avoid collaboration with other subjects in this study. However, you are free to consult reference books and subject matter experts as needed. To the extent practical, work in your everyday environment.

d. As needed, I will prepare typed copies of the passages you write before administering them to students. If you include illustrations (graphics) with your revision, I will photoreproduce them.

Each writer was also given the following information:

DESCRIPTION OF THE TARGET AUDIENCE

This passage will be administered to students in the General Medical Orientation or other early training for combat medics at the Academy of Health Sciences, U.S. Army. Most of these students are from 17 to 25 years old. Approximately one-third are female. The reading grade level of the students is generally comparable to a tenth- to twelfth-grader. These students must have a General Technical (GT) score of 90; this means that approximately the lower 31% of the potential pool of candidates has been excluded in the selection of these students for training. The GT score represents a composite of Word Knowledge (including Paragraph Comprehension) and Arithmetic Reasoning.

These students are from all parts of the country. They belong to diverse ethnic groups and races. Perhaps 10% are native speakers of Spanish. They tend to be from less affluent homes than the average college students. Their motivations for entering the Army may involve economic, patriotic, and personal educational goals.

TESTING PROCEDURES

First, each student will be allowed 10 minutes to read a passage. This will be either an original passage or a revised version prepared by a writer-subject. Second, each student will then take the test without looking further at the passage; this will be a measure of memory for the passage. Third, each student will be administered a second copy of the test and will be encouraged to refer to the passage for answers; this will be a measure of comprehension.

The writers were instructed:

> After revising the original passage, please rate your version of the passage by using COPY 2 of the tentative instrument. This time, make a clear red line (mark) on each thermometer to record your assessment of your revision in terms of that item of the instrument. Please use your best and most considered judgment in making these red marks. These will be the basis for determining the validity of the items of the instrument.

The writers were also asked to comment upon the validity, correctness, and relevance of each item in the passage rating instrument.

Judges' Ratings of Passages

After several hours of training and practice together, each judge was given a package of randomly sequenced passages. Each package included copies of the 2 original passages, 42 revisions of the "Role" passage, and 31 revisions of the "Cell" passage. Each judge independently rated these 75 passages on the 11 applicable items of the instrument. Later, a panel of six judges, including four of the same people, each rated one-half of the passages for content; that is, each indicated how many items of the appropriate multiple-choice test could be answered by reading the passage.

Administration of Passages to Students

Each student package included (1) one copy of a passage alone for use in the Memory Condition, (2) the first copy of the test alone, and (3) a second copy of the passage with the test attached for use in the Comprehension Condition. A distinct colored cover was used for each subpart. Two machine-gradeable answer sheets were also included in each package. Sixty of these packages were assembled for each of the original passages, and 12 packages were assembled for each of the revised passages. The packages, randomly sequenced by passage number, were given to the students' regular instructors, who were briefed on the procedures of allowing 10 minutes for the first reading, 15 minutes for a closed-book test, and 15 minutes for an open-book test. Before participating, each student was asked to sign a voluntary consent form, which also gave permission for retrieval of aptitude data from the Armed Services Vocational Aptitude Battery. The materials were administered in the students' usual classrooms.

Results

Were Revisions More Effective Than the Original Passages?

Four separate ANOVAs were performed for the two passage topics and two dependent measures, Memory and Comprehension. However, there was no significant main effect ($p > .05$), even though there were 551 cases for he "Role" passages and 411 cases for the "Cell" passages. Thus, the writers were collectively unable to improve the effectiveness of the passages. Some writers were apparently successful, but the successes of some writers were balanced by the failures of others.

Which Criteria Are Predictive for Writers?

Partial correlations were computed controlling for Aptitude (Armed Forces Qualification Score) and Content. There were ten dependent measures in two different subfiles by topic. The dependent measures include Memory, its four subscores by level, Comprehension, and its four subscores by level. Consult Table 1 for those criteria which were significantly correlated with performance on at least one of these variables ($p \leq .01$). The scales which were strongly and positively correlated with performance were the ones for vocabulary, simplicity and shortness of sentences, use of illustrations, statement of objectives, and clarity of organization. Subsequent regression analyses on data aggregated by passages, including both topics, tend to add support for the scales for clarity of anaphoric references; use of examples, metaphors, and analogies; and use of devices to tap the reader's knowledge. Scales receiving little support for use by writers are: one asking writers to report their practice of rereading their own writing; one involving the provision of student practice exercises; and one related to the variety, diversity, and informality of a passage.

Which Criteria Are Predictive for Judges?

Partial correlations were computed as stated in the preceding paragraph. Those which were strongly correlated without negative coefficients (Table 1) were the scales for vocabulary; use of examples, metaphors, and analogies; use of illustrations; use of devices to tap the reader's knowledge; statement of objectives; and provision of student practice. Subsequent regression analyses, on data aggregated by passages and including both topics, tend to add support for the scales related to statement of objectives; use of examples, metaphors, and analogies; and simplicity and shortness of sentences. However, the regression analyses indicate a negative rather than a positive role for the provision of student practice.

What Weights Should Be Used for the Criteria?

Table 2 gives equations, computed by stepwise multiple regression, in terms of the beta coefficients. Beta coefficients are standardized weights, useful for prediction of actual scores if each variable is also standardized, that is, expressed as its deviation from its mean and divided by its standard deviation. Since these regression equations are based upon aggregation of

Table 2

Beta Coefficients of Regression Equations Predicting Four Levels of Memory and Comprehension

Dependent measures	R	R^2 Adj	Sig F
Memory condition			
Subscores for word meanings:			
.35 METF +.26 Content Control	.44	.16	.0051
Subscores for sentence meanings:			
.44 Content Control +.37 Aptitude +.40 REFD - .29 ILLD +.42 SENJ - .27 PRCF -.26 VOCF	.69	.39	.0001
Subscores for intersentence meanings:			
.51 Content Control -.30 PRCF +.26 Aptitude	.62	.34	.0000
Subscores for global meanings:			
.50 REFD - .38 OBJJ +.41 METJ +.25 Content Control -.27 ORGD	.66	.37	.0001
Total scores:			
.68 Content Control +.25 Aptitude +.25 VOCJ -.30 PRCF +.26 REFD	.72	.47	.0000

Note: The dependent measures for memory and comprehension were standardized by topic, using standard scores for the two topic subfiles. Cases were then combined into a single file of passages or cases. Twenty-two passages were deleted because of missing values. Thus, the multiple regressions in this table are based upon 28 "Role" passages and 25 "Cell" passages (n = 53).

Table 2

Continued

Dependent measure	R	R^2 Adj	Sig F
Comprehension condition			
Subscores for word meanings:			
.29 OBJF +.58 Content control +1.02 VOCJ +.64 VOCD -.58 VOCF -.45 ORGD +.33 ORGF -.33 VARJ +.20 ELBD	.81	.58	.0000
Subscores for sentence meanings:			
.43 Content Control +.33 REFF -.32 ELBJ +.26 REFJ	.61	.32	.0001
Subscores for intersentence meanings:			
.26 KNLF +.32 Content Control -.38 PRCJ +.27 OBJJ	.52	.20	.0044
Subscores for global meanings:			
-.52 PRCJ +.32 Aptitude -.27 METD +.56 OBJD -.32 ORGD -.38 ORGJ +.23 REFF	.74	.47	.0000
Total scores:			
.46 Content Control +.28 REFF +.25 REFJ +.21 Aptitude	.61	.32	.0001

individual cases into passage groups, passage-nonspecific effects are muted. For this reason, and also because both topics were included (after standardizing the dependent measures by their means and standard deviations within the appropriate topic subfiles), the equations explain a higher proportion of variance ($\bar{R}^2$ Adjusted) at the aggregated level than they do at the individual level within topic subfiles. At the level of the individual reader in the topic subfiles, these regression equations are significantly correlated with most of the corresponding dependent measures ($p \leq .001$ in 15 instances, $p \leq .01$ in 2 instances, $p \leq .05$ in 2 instance, but $p > .05$ in 1 instance). However, the average r is only .2289 ($r^2 = .05$) for individuals within the topic subfiles.

Discussion

When substantial information is available, one can predict a substantial proportion of the passage-specific variations in students' memory and comprehension of an expository passage. As previously indicated by Bormuth (1969), there are a large number of linguistic variables which independently affect the comprehension process. For any dependent measure, the regression equations generally contain variables other than the traditional ones related to word familiarity and shortness of sentences. This study serves to illustrate that the specific predictive variables also change when the dependent measures are varied. Even administering a test on a closed-book basis (Memory Condition) rather than an open-book basis (Comprehension Condition) changes the nature of the regression equation. Also, the regression equations change according to the level of passage information tested.

This predictive ability is qualified by the need for substantial advance information. This is not entirely a problem of being able to assess any specific language, content, or aptitude variable. It is also a problem of knowing which regression equation will be applicable to one's specific dependent measure and one's topic. Short of slavish adherence to one formula, however, the misapplication of a regression equation should reduce efficiency of prediction but cause no substantial harm to the effectiveness of instruction.

This study tends to support traditional notions of the factors which contribute to effective written instruction. Notably, the results emphasize the importance of content and of student aptitude (language knowledge). Also, the results tend to support the simplification of vocabulary and sentence structure; the use of examples, metaphors, and analogies; the use of illustrations (graphics); the use of devices to tap the reader's knowledge; the statement of objectives; and steps to improve the clarity of anaphoric references. It provides little support for seeking just the right level of explanation or elaboration, attempting a very informal and varied writing style, or the provision of student practice. This last strategy may have been ineffective in this study due to the time limits placed upon students. The positive effects of an informal and varied writing style may be ones related to motivation rather than the cognitive measures used in this study.

The most surprising result of this study was the failure of the writers as a group to improve the comprehensibility or memorability of two passages, even though the passages had been chosen because they seemed difficult to understand. This was true even though the writers were generally professional developers of instructional materials. This was true even when the writers had in hand a set of guidelines for judging the comprehensibility of passages and even when they knew they were participating in an experiment related to the comprehensibility of passages. This study indicates that we have substantial knowledge about the characteristics of effective written instruction but that we are generally unable to apply this knowledge with good results.

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APPENDIX A

Original Passage 1

The following passage was taken from Soldier's Manual FM 8-9181/2, pp. 1-10 and 1-11. This text was developed to guide individual soldiers in learning tasks related to their job. This passage was a paragraph in the text's introductory section.

YOUR ROLE IN COMBAT

A significant and singularly important morale factor that enables a soldier to be successful on the battlefield is the immediate availability of competent medical care and treatment. The Army Medical Department is established along functional lines in order to provide timely medical treatment to the battlefield casualty. When a soldier becomes a casualty, the question of how and where treatment is to be provided depends on both the nature of the injury and where the injury was received on the battlefield. A patient with minor injuries and/or diseases is treated as near as possible to his own unit in order that timely return to duty will not be delayed by excessive movement. Patients with more serious diseases or injuries are evacuated from the battlefield to a medical treatment facility which has a better capability of treatment. A basic rule to remember is that a patient is evacuated for treatment no further than is absolutely necessary. Also medical personnel within a medical treatment facility should not routinely attempt to perform those treatment procedures that are not a part of the basic design or capability of their facility. For example, personnel in a Battalion Aid Station should not attempt to perform procedures normally provided by a hospital. When medical personnel in a facility attempt to routinely perform treatment procedures beyond the capabilities of the facility or when a patient is unnecessarily evacuated beyond medical treatment facilities which have the capability to provide proper treatment, an unusual burden is placed on administrative and logistical support systems which delays the soldier being returned to duty. You, as a medic, have an interest in the battlefield casualty which is continuous from time of injury until the soldier is returned to duty. While you do not accompany the patient through all of the treatment phases nor from treatment facility to treatment facility, the results of tasks that you perform in the course of treatment of the patient do, in fact, follow the patient and are a significant part of the patient's medical management program. Consider then, as you read the following, how the tasks you perform relate to the recovery of the patient. The casualty is located, given battlefield first aid, and protected from further injury. Evacuation procedures are set into motion and the patient is made ready for movement. The location, degree of urgency and the nature of injury will generally dictate the mode of evacuation to use, the provision of enroute support, and the selection of the most appropriate destination medical treatment facility. When the patient arrives at the receiving facility, resuscitative care will commence. Resuscitative

care procedures are those which will contribute to the achievement of physiological stabilization. The next phase of the patient's treatment--definitive care--may or may not be located within the same treatment facility. Should the patient require further evacuation, preparation for further evacuation should be commenced without delay, and in accordance with the existing evacuation policy. Definitive care procedures are generally those which completely arrest the effects of the trauma, preserve life, preserve limb and function. and permit either evacuation to large treatment facilities with long-term care capability, or the return to some form of duty. Throughout this battlefield system of health service support certain activities must be provided for the patient every step of the way. The patient's medical condition must be continually evaluated so that timely decisions can be made regarding the nature of the care required, selection of evacuation means, or return to duty as soon as and as far forward as possible. We must always keep track of the patient. The patient's location in the system must be known, and the patient's condition and status must be current, accurate, and immediately available. The patient must be protected and every effort must be made to eliminate those threats and stresses which would complicate or retard the recovery process or to cause new or additional trauma. The patient must be properly fed. This feeding includes not only nutritional considerations for normal existence, but also those specific modifications of diet which are essential to the success of the patient's overall care

Original Passage 2

The following passage was extracted with permission from the Technical Manual of the American Association of Blood Banks, eighth edition, copyright 1981, pp. 265-266:

RED CELL COMPONENTS AVAILABLE

Whole Blood

Acute massive blood loss is best treated with whole blood. Depletion of intravascular volume is the pathogenesis of hypovolemic shock. Thus, rapid restoration of intravascular volume is of primary importance. When whole blood is not available, components may suffice. However, red blood cells and crystalloid (electrolyte) solutions supplemented by colloid (protein) solutions are less cost-effective than whole blood. If fresh frozen plasma is used along with red blood cells to expand blood volume, the recipient experiences twice the risk of hepatitis exposure. Infusions to restore intravascular volume should be started immediately, beginning with readily available crystalloid solutions. If blood loss exceeds one-third of the patient's blood volume, crystalloid solutions alone will not sustain blood volume and colloid solutions may be necessary. Such circumstances are an absolute indication for whole

blood. It is possible to maintain adequate supplies of platelet concentrates and cryoprecipitate and still have whole blood available for volume replacement if the plasma is returned to the red cells after component preparation. The resulting product, whole blood, modified, has virtually the the same hemostatic properties as stored whole blood.

Whole blood, with hematocrit adjusted by removing plasma, is the component of choice for exchange transfusion. In neonatal exchange transfusion, the age of the blood is important. Blood less than five days old assures plasma electrolyte concentrations within limits that are tolerable for infants, and also assures adequate red blood cell content of 2,3-diphosphoglycerate (2,3-DPG).

Red Blood Cells

Red blood cells is the component of choice to restore or maintain oxygen-carrying capacity. If the patient has chronic anemia, congestive heart failure, or is elderly or debilitated, rapid shifts of blood volume are not well tolerated. Transfusing red blood cells maximizes oxygen-carrying capacity and minimizes blood volume expansion. Nonhemolytic transfusion reactions occur less frequently after transfusions of red cells than after whole blood.

The exclusive use of red blood cells for transfusion during surgery is controversial. Studies have shown that 1000 to 1200 ml of operative blood loss can be replaced by electrolyte and/or colloid solutions alone without transfusion. In a large national survey, the transfusion requirement for 65% of patients requiring operative transfusions was four units or less. Most of these patients should receive red blood cells and crystalloid solutions because they require simply restitution of oxygen-carrying capacity. However, when surgical patients require significant volume expansion as well as oxygen transport capacity, whole blood or whole blood, modified, should be transfused rather than red blood cells augmented by albumin solution or frozen plasma. Not only is this use of albumin expensive, it also wastes resources, since approximately 450 ml of plasma must be processed to yield one 250-ml bottle of 5% albumin.

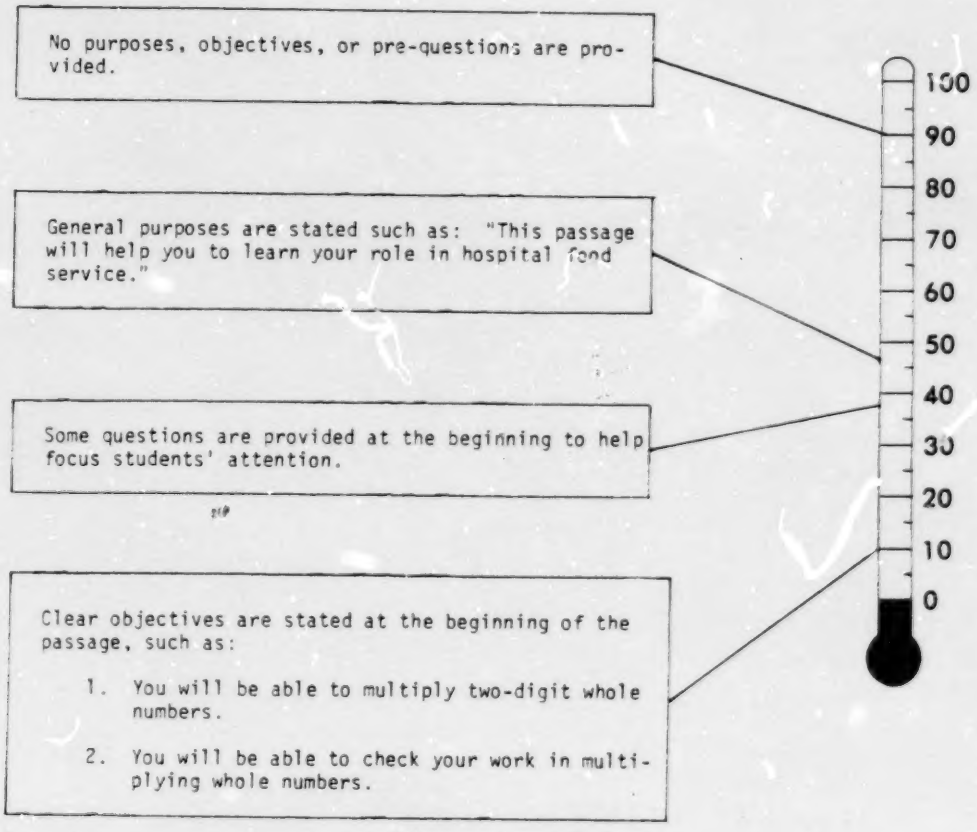
Fresh Whole Blood

If completely tested components are available, there are no valid indications for transfusing fresh whole blood before completing tests for HBsAg or the presence of unexpected antibodies. An order for fresh blood should be interpreted by the blood bank staff as a cry for consultative help, since the advantages of freshly drawn blood are often misunderstood by the patient-care physician. When such a request occurs, the appropriate response is a diagnostic plan followed, usually, by specific component therapy. For example, when a massively transfused patient bleeds, the diagnosis of dilutional thrombocytopenia can be established by a platelet count. Appropriate therapy is transfusion with platelet concentrates. For most such cases, the number of platelets in one unit of fresh whole blood would be insufficient. Fresh whole blood is

impractical for attempted replacement of documented deficiencies of coagulation factors because of the large volume necessary to restore effective concentration. Thus, if a patient is bleeding because of deficiency of Factor VIII or consumption of fibrinogen, a superior ratio of clotting activity to volume makes Factor VIII concentrate or cryoprecipitates preferable for therapy to fresh whole blood.

APPENDIX B
EXAMPLE OF AN ITEM IN THE INSTRUMENT
(Reduced; Designated in Table 1 as OBJD, OBJF, and OBJJ)

4. WRITING AS INSTRUCTION.
FACTOR 4A: ARE OBJECTIVES OR PURPOSES INDICATED?


No purposes, objectives, or pre-questions are provided.
General purposes are stated such as: "This passage will help you to learn your role in hospital food service."
Some questions are provided at the beginning to help focus students' attention.
Clear objectives are stated at the beginning of the passage, such as:
1. You will be able to multiply two-digit whole numbers.
2. You will be able to check your work in multiplying whole numbers.
100
90
80
70
60
50
40
30
20
10
0

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